## AMENDMENTS TO THE SPECIFICATION:

Please substitute the following paragraphs in the specification for corresponding paragraphs previously presented. A copy of the amended specification paragraphs showing current revisions is attached.

The paragraph beginning at page 8, line 19 (last paragraph and bridging to page 9):

FIGURE 1 shows a polyphase electrical generator 10. The generator has a cylindrical rotor 12 surrounded by an annular stator 14. The rotor is on a rotating shaft 16 that may be driven by a gas turbine, steam turbine or other drive mechanism. A conventional construction of polyphase electrical generators and other machines is to use two or more electrical winding phases arranged to produce voltage waveforms that are identical except in phase. Other typical arrangements of electrical windings are six, nine and twelve phases, although substantially any number of phases is possible. In a conventional three-phase generator, the voltages and currents from each of phase winding circuits are identical, but offset by a 120~~%~~ degree time phase difference. The embodiment disclosed here is a three-phase synchronous generator 10, but the invention is applicable to all polyphase electrical machines in which the number of electrical phases in a multiple of three, e.g., 3, 6, 9, and so on. Moreover, the invention may be adapted to polyphase electrical machines having a number of electrical phases that are not a multiple of three, such as 4, 5, 7, and so on.

The paragraph beginning at page 13, line 10 (last paragraph and bridging to page 14):

In the example shown in FIGURE 7, the winding portion A1 56 represents 63% of the phase A winding, and winding portion A2 58 represents the remaining 37% of the total phase A winding 54. Similarly, winding phases B and C are divided exactly in the same 63%-37% manner as is the phase A winding. The high voltage portion of phase A1 is connected to the low voltage portion of phase C62 at point B2 (a terminal tap 50) in each winding. The low voltage end of phase A1 is connected to phase B at B2. The line-to-line voltage of the armature winding is a resulting sum of the voltages on phase A1, A2 and B2. In the hybrid Delta-Wye configuration shown in Figure 7, the 100% contribution of phase A, and the 37% of phase B result in a total line-to-line voltage that is ~~122~~ 131% of the phase voltage, after the phase angles of phase A and B are taken into account. This same ~~122~~ 131% magnitude voltage is produced by the combination of the other two phases (100% of C plus 37% from A2, 100% of B plus 37% C2) in the armature winding. The three resulting line-to-line phase voltages are equal in magnitude and displaced in time by 120~~%~~ degree, as is conventional for a three-phase machine. The ~~122~~ 131% line-to-line voltage level is a level that is not available in conventional generators connected in either the Delta or Wye configurations.

The paragraph beginning at page 14, line 10 (last paragraph):

An equation (1) has been developed that correlates the line-to-line voltage of a generator to the proportion of the armature phase windings that are arranged in a Delta topology, where the rest of the windings are in a Wye topology. The equation is as follows:

$$\cancel{(1) \quad V_{LL} = \left| Xe^{j\pi/6} + \sqrt{3}\,(1 - X) \right|}$$

$$\underline{(1)\quad V_{LL} = 2\left\{Sin\left(\frac{X\pi}{6}\right) + \sqrt{3}Sin\left(\frac{(1-X)\pi}{6}\right)\right\}}$$

where: "$V_{LL}$" is the line-to-line voltage as a proportion of the phase winding voltage level, and;

"X" is the fraction of a phase winding in a Delta topology~~, and~~

~~"j" is the complex operator, wherein $j^2 = -1$~~.

The paragraph beginning at page 15, line 12 (second paragraph):

FIGURES 9, 10, 11 and 12 illustrate alternative winding topologies that can be configured using the hybrid Delta-Wye winding topology. In particular, FIGURE 9 shows a conventional Delta topology 42 in which each phase winding 20 is connected end-to-end to the ends of other phase windings. FIGURE 10 shows another winding topology in which the phase windings 20 have been arranged by connecting end turn taps 50 of one phase winding to the end of another phase winding in order to form a mini-Delta topology 60. In addition, a mini-Wye topology 66 is formed using the end tap as a central node 28. The fraction of the winding that is in a Delta topology is 75%, based on the end tap 50 being located at an end turn that is at a position three-fourths (75%) the length of the phase winding. The line-to-line voltage ($V_{LL}$) for a 75% Delta winding topology is ~~114.5~~ 122% of the phase voltage level.

The paragraph beginning at page 15, line 25 (last paragraph and bridging to page 16):

As shown in FIGURE 11, the line-to-line voltage level is set at ~~132~~ 141% of the phase voltage by configuring the winding topology such that one-half (50%) of each

phase winding is arranged in a mini-Delta topology. The winding topology is reconfigured by tapping the end turns with a terminal tap to achieve the desired percentage of Delta topology for the armature winding. FIGURE 12 shows a conventional Wye topology 22 in which one end of each phase winding circuit 20 is connected to a common node 28 and the opposite ends are connected to armature output terminals 26. Accordingly, FIGURES 9 to 12 illustrate that the output voltage level (as a percentage of the phase winding voltage level) of a polyphase generator can be set relatively at substantially any level within a certain range (such as 100% to 173%) by configuring the armature winding as a hybrid combination of Delta and Wye topologies. Moreover, the configuration of the winding topology is relatively easily set by selecting an appropriate winding end turn to tap that provides a prescribed Delta topology percentage to obtain the desired voltage level.

**AMENDMENTS TO THE CLAIMS:**

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. to 7. (Cancelled).

8. (Allowed) A method for connecting armature windings in an electrical machine, wherein the armature windings include a plurality of phase windings, said method comprising:

a. segmenting each of the plurality of phase windings into a first winding segment and a second winding segment by establishing a connection point at one of a plurality of available mid-winding connection points on each of said phase windings;

b. at the established mid-winding connection point, connecting an end of the first winding segment in each phase winding to an end of the first winding segment in another of said phase windings to form a Delta winding topology, and

c. at the established mid-winding connection point, connecting a first end of one of said second winding segments to a plurality of connected ends of said each of said first winding segments to form a Wye topology about each mid-winding connection point.

9. (Allowed) A method as in claim 8 wherein the available connection points are at end turns of the phase winding, and the established connection point is a contact tap at a selected end turn of the phase winding.

10. (Allowed) A method as in claim 8 wherein the first and second winding segments are in-phase.

11. (Allowed) A method as in claim 8 wherein an opposite end of said second winding segment is connected to an external terminal of said windings.

12. (Allowed) A method as in claim 8 where said plurality of phase windings include three phase windings, and each of said three phase windings has an established connection point, and further comprising forming an external connection at an opposite end of each of the second winding segments to establish a three-phase power connection to the phase windings.

13. (Allowed AND AMENDED) A method for connecting armature windings in an electrical machine, wherein the armature windings include a plurality of phase windings, said method comprising:

a. segmenting each of the plurality of phase windings into a first winding segment and a second winding segment by establishing a connection point at one of a plurality of available connection points on said phase winding;

b. at the established connection point, connecting an end of the first winding segment in each phase winding to an end of the first winding segment in another of said phase windings to form a Delta winding topology;

c. at the established connection point, connecting a first end of one of said second winding segments to a plurality of connected ends of said each of said first winding segments to form a Wye topology about each connection point, and

d. establishing a line-to-line output level ($V_{LL}$) between each of said phase windings in accordance with the following expression:

$$\cancel{V_{LL} = \left| Xe^{j\pi/6} + (1 - X) \right|}$$

$$\underline{V_{LL} = 2\left\{ Sin\left(\frac{X\pi}{6}\right) + \sqrt{3}Sin\left(\frac{(1-X)\pi}{6}\right)\right\}}$$

where: "$V_{LL}$" is the line-to-line voltage as a proportion of a phase winding voltage level, and

"X" is a fraction of a phase winding arranged in a Delta topology~~, and~~

~~"j" is a complex operator, wherein $j^2 = -1$~~.

## AMENDMENTS TO THE DRAWINGS

The attached replacement sheets of all of the drawings include changes to Figures 7, 10, 11 and 12. The replacement sheets replaces the original sheets. Also attached are marked up copies of Figures 7, 10, 11 and 12 that highlight the changes made to the drawings.

Attachment: Replacement Sheet(s)

## REMARKS/ARGUMENTS

Reconsideration of this allowed application is respectfully requested. This amendment corrects a mathematical representation of the invention that inadvertently was included the application and claim 13.

No new subject matter is being added. The invention is an adjustable armature topology that is fully disclosed in the application. The correction to be made by this amendment relates to a mathematical representation of the disclosed armature topology.

Pages 8 and 13 are corrected because the term "120 degrees" was incorrectly stated as "120%". This was a typographical error not caught until prosecution of this divisional application.

The other changes relate to correction of the mathematical representation of the armature topology expressly disclosed in the application. As is shown by the following derivation, the mathematical representation is inherent from the armature winding topology that is fully disclosed in the application. The error in the mathematical representation was inadvertently included in the original application and was not detected until after this divisional application was filed. The error in the mathematical representation also lead to the errors in the percentages of phase voltage reported in the application, e.g., from 122 to 131%. Similarly, the voltages indicated in figures 7, 10, 11 and 12 are being amended in view of the correction of the mathematical representation.

The correct mathematical representation is inherent from the disclosed topology. A person of ordinary skill in the art would have recognized the correct mathematical

representation once having derived the representation for the disclosed topology. Description of subject matter inherent from the disclosed invention may be added to an application without violating the prohibition on adding new subject matter. *Tronzo v. Biomet, Inc.*, 156 F.3d 1154, 1159, 47 USPQ2d 1829, 1834(Fed. Cir. 1998)(For a disclosure to be inherent, "the missing descriptive matter must necessarily be present in the [original] application's specification such that one skilled in the art would recognize such a disclosure.").

Derivation of Voltages in a Combination Delta-Wye Generator Winding

i. Introduction

This section presents the derivation of an expression for the voltage generated in a combination delta-wye winding in an electric generator. The overall arrangement of the windings in a three-phase group is shown in Figure 1 below which corresponds to Figure 7 of the original application. Each of the three phases is divided into two portions, such as A1 and A2 for Phase A. In general, portions A1, B1, and C1 are connected to form a delta connected winding and the portions A2, B2, and C2 form extensions from the corners of the delta. As the fraction of the phase winding assigned to the delta portion varies from zero to 100%, the line-line voltage developed by the combined windings will vary from 100% of the phase voltage to 173% of the phase voltage.

In the instance shown in Figure 1, the Delta portion of the winding is 63% of the phase winding. The remaining 37% of the winding forms the "Wye" portion. The voltage produced between any two of the line terminals will be 131% of the phase voltage. The derivation shows that the mathematical representation stated in the specification is simply

a representation of the winding topology that is expressly shown in Figure 7 of the original application.

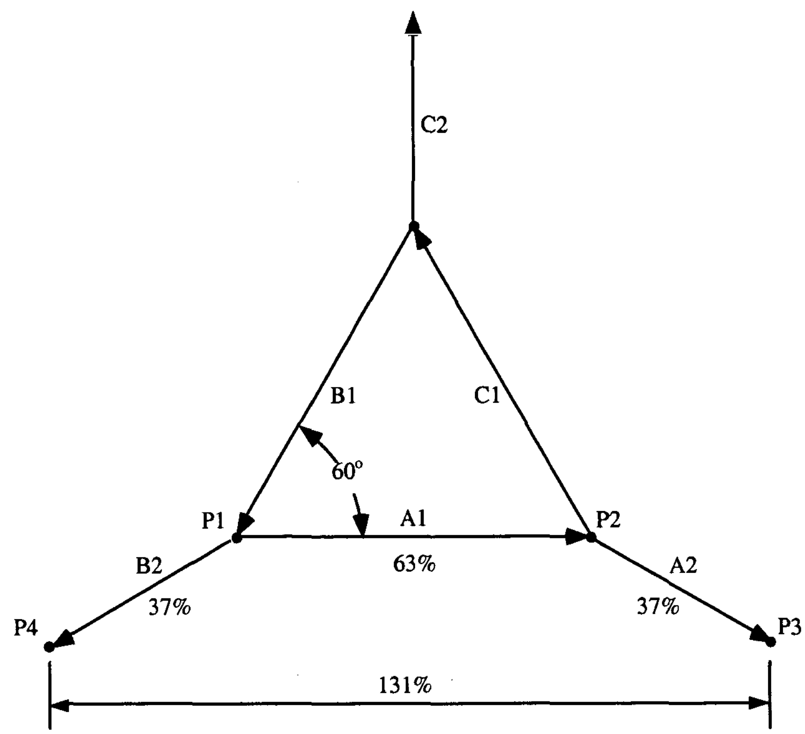


**Figure 1 (Fig. 7 of Appln) – Arrangement of Phase Segments to Form a Delta-Wye Winding Assumptions**

To derive a mathematical representation that generally describes the line-to-line voltage for the topology of the Delta-Wye Winding, two assumptions are needed. Both of these assumptions are based on and evident from the expressed disclosure of the original application. The assumptions are:

- The three phases are identical in their construction so that the voltages produced by the phases are identical except for the differences in phase angle.

The phases are constructed in 60-degree phase belts. That is, the conductors in a given phase (and layer of the winding) span 60 electrical degrees.

These assumptions are expressly in the disclosed armature topology of this application. In particular, the specification states as page 9 that "In a conventional three-phase generator, the voltages and currents from each of the phase winding circuits are identical, but offset . . ." Accordingly, the actual Delta-Wye topology and the assumptions needed to derive a mathematical representation of the line-to-line voltage from the disclosed topology are both expressly disclosed in the application.

ii. Analysis

The armature winding that is to be connected in a delta-wye configuration is arranged in the generator in a series of phase belts, as shown in Figure 2 below. Figure 2 shows schematically and in end view the generator windings described in the application at pages 9 to 11 and shown schematically by Figures 1 to 12 of the application. The arrangement of winding shown in Figure 2 is generic (and thus inherent) to the generator winding disclosed in the application.

The winding is shown in Figure 2 below as a single layer with the positive conductors in a phase being placed 180 degrees away from the negative (return) conductors. The choice of a single layer, full pitch winding is for convenience of the derivation of the mathematical representation and is generic (for purposes of the derivation) to all of the armature windings disclosed in the application.

Figure 2 below depicts coils arranged by phases. In a machine each of the coils will represent one or more complete turns that form the armature winding. For the

sake of simplicity, this analysis considers that each coil contains a single turn so that the terms “coil” and “turn” can be used interchangeably. In an actual embodiment of the delta-wye winding, one must divide the winding into portions 1 and 2 (A1 and A2) by groups of coils rather than turns.

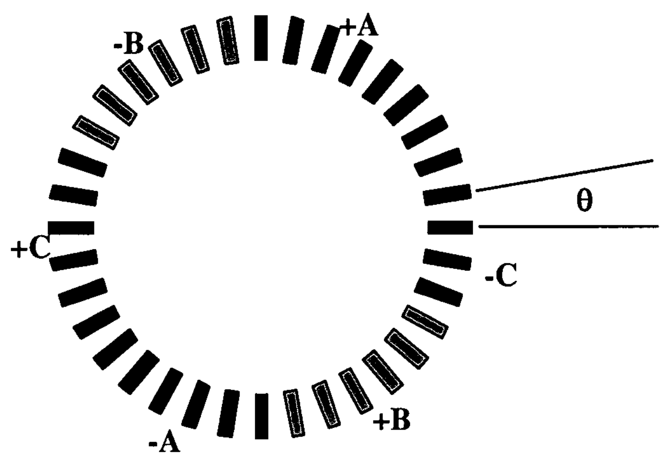


**Figure 2 – Arrangement of Coils in 60-Degree Phase Belts**

The specific arrangement in Figure 2 shows six coils in each phase offset by an angle, □, between coils. In this instance, the angle is given in electrical degrees or radians so that the result is equally applicable to a generator with more than two poles. In general, there will be N such coils in each phase belt. Let “n” of the coils be assigned to the Delta portion of the winding and the remaining “m” turns be assigned to the Wye portion. Therefore,

$$N = n + m \tag{1}$$

Let X be the fraction of the winding that is assigned to the delta portion, so

$$X = \frac{n}{N} = \frac{n}{n+m} \tag{2}$$

X must necessarily be between zero and one. Based on Eqs. 1 and 2,

$$\begin{aligned} n &= X\,N \\ m &= (1 - X)\,N \end{aligned} \tag{3}$$

iii. Distribution Factor

The distribution factor, $k_d$, also known as the breadth factor, describes the voltage generated in a set of coils placed in adjacent positions in a winding as in Figure 2 and connected in series to form a winding. If each coil would have produced a voltage, $V_c$, and the coils are located in slots in the generator separated by the angle, □, then the arithmetic sum of the voltages in N coils would be

$$V_{sum} = N\,V_c \tag{4}$$

whereas the net voltage accounting for the phase difference of the coils is denoted as $V_{net}$. The distribution factor is the ratio of the net voltage to the sum of the coil voltages, so

$$k_d = \frac{V_{net}}{V_{sum}} = \frac{\sin\left[N\frac{\theta}{2}\right]}{N\sin\left[\frac{\theta}{2}\right]} \tag{5}$$

Equation 5 is well known and is presented in a number of texts on electrical machines.

The voltage developed by "n" coils in series is

$$V(n) = nV_c k_d = V_c \frac{\sin\left[\frac{n\theta}{2}\right]}{\sin\left[\frac{\theta}{2}\right]} \tag{6}$$

iv. Voltage Generation

The voltage generated in the winding can be obtained by combining the contributions from the portions of the phase windings connecting two line terminals. Figure 3 shows a portion of the winding in Figure 1, corresponding to segments B2, A1, and A2. The voltage of interest is $V_{LL}$ between the points P3 and P4.

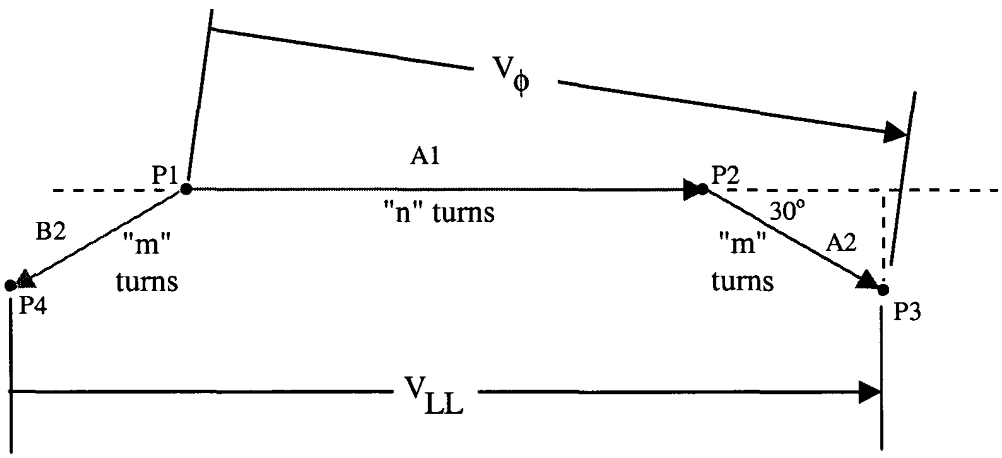


**Figure 3 – Voltage Generation in Winding Segments**

The voltage between points P3 and P4 is the sum of the portion from A1 representing "n" turns and a portion from A2 representing "m" turns minus a portion from B2 representing "m" turns. Thus,

$$V_{LL} = V_{A1} + V_{A2} - V_{B2} \tag{7}$$

where $V_{A1}$, $V_{A2}$, and $V_{B2}$ are the voltages in each segment. The voltages in Eq. 7 have both a magnitude and a phase angle. For convenience, the voltage developed in segment

A1 will be assigned a phase angle of zero degrees. The phase angles of $V_{A2}$ and $V_{B2}$ can be determined from the figure to be -30° and -150° respectively.

The magnitude of the voltage in segment A1 generated by "n" turns is

$$V_{A1} = V_c \frac{\sin\left[\frac{n\theta}{2}\right]}{\sin\left[\frac{\theta}{2}\right]} \tag{8}$$

The magnitude of the voltage in segments A2 and B2 generated by "m" turns is

$$V_{A2} = V_{B2} = V_c \frac{\sin\left[\frac{m\theta}{2}\right]}{\sin\left[\frac{\theta}{2}\right]} \tag{9}$$

The net voltage between the points P3 and P4 accounting for the phase angles of the three segments is thus

$$V_{LL} = V_{A1}\angle 0 + V_{A2}\angle -30° - V_{B2}\angle -150° \tag{10}$$

The voltage components in the A2 and B2 segments that are orthogonal to segment A1 cancel, so the resulting voltage in the three segments is in phase with the voltage in segment A1. Thus the magnitude of the voltage is

$$|V_{LL}| = V_c \left\{ \frac{\sin\left[\frac{n\theta}{2}\right]}{\sin\left[\frac{\theta}{2}\right]} + \sqrt{3}\frac{\sin\left[\frac{m\theta}{2}\right]}{\sin\left[\frac{\theta}{2}\right]} \right\} \tag{11}$$

The magnitude of the voltage generated in one phase of the winding (segments 1 and 2 of any one phase) is

$$V_\phi = V_c \frac{\sin\left[\frac{N\theta}{2}\right]}{\sin\left[\frac{\theta}{2}\right]} \tag{12}$$

so the line-line voltage of the delta-wye winding as a fraction of the phase voltage is

$$|V_{LL}| = \frac{V_c\left\{\frac{\sin\left[\frac{n\theta}{2}\right]}{\sin\left[\frac{\theta}{2}\right]} + \sqrt{3}\frac{\sin\left[\frac{m\theta}{2}\right]}{\sin\left[\frac{\theta}{2}\right]}\right\}}{V_c \frac{\sin\left[\frac{N\theta}{2}\right]}{\sin\left[\frac{\theta}{2}\right]}} = \frac{\sin\left[\frac{n\theta}{2}\right] + \sqrt{3}\sin\left[\frac{m\theta}{2}\right]}{\sin\left[\frac{N\theta}{2}\right]} \tag{13}$$

Based on the assumption that each phase belt of N coils spans 60 electrical degrees (□/3 radians), it is possible to write

$$\begin{aligned} \frac{n\theta}{2} &= X\frac{\pi}{6} \\ \frac{m\theta}{2} &= (1-X)\frac{\pi}{6} \end{aligned} \tag{14}$$

and since

$$\frac{N\theta}{2} = \frac{\pi}{6} \tag{15}$$

the expression for the voltage in Eq. 13 becomes

$$|V_{LL}| = 2\left\{\sin\left[\frac{X\pi}{6}\right] + \sqrt{3}\sin\left[\frac{(1-X)\pi}{6}\right]\right\} \tag{16}$$

Equation 16 is a correct mathematical representation of the delta-wye topology shown in the application as filed. This equation should be included in the application, instead of the incorrect equation that was in the application as filed.

The derivation of equation 16 demonstrates that the equation is a representation of the winding topology disclosed in the application and, thus, is inherent to the original disclosure of the application. The derivation also establishes that the equation presented in the original application is in correct and should be corrected.

Entry of this 312 Amendment is requested. If any small matter remains outstanding, the Examiner is requested to telephone applicants' attorney. Prompt reconsideration and allowance of this application is requested.

Respectfully submitted,

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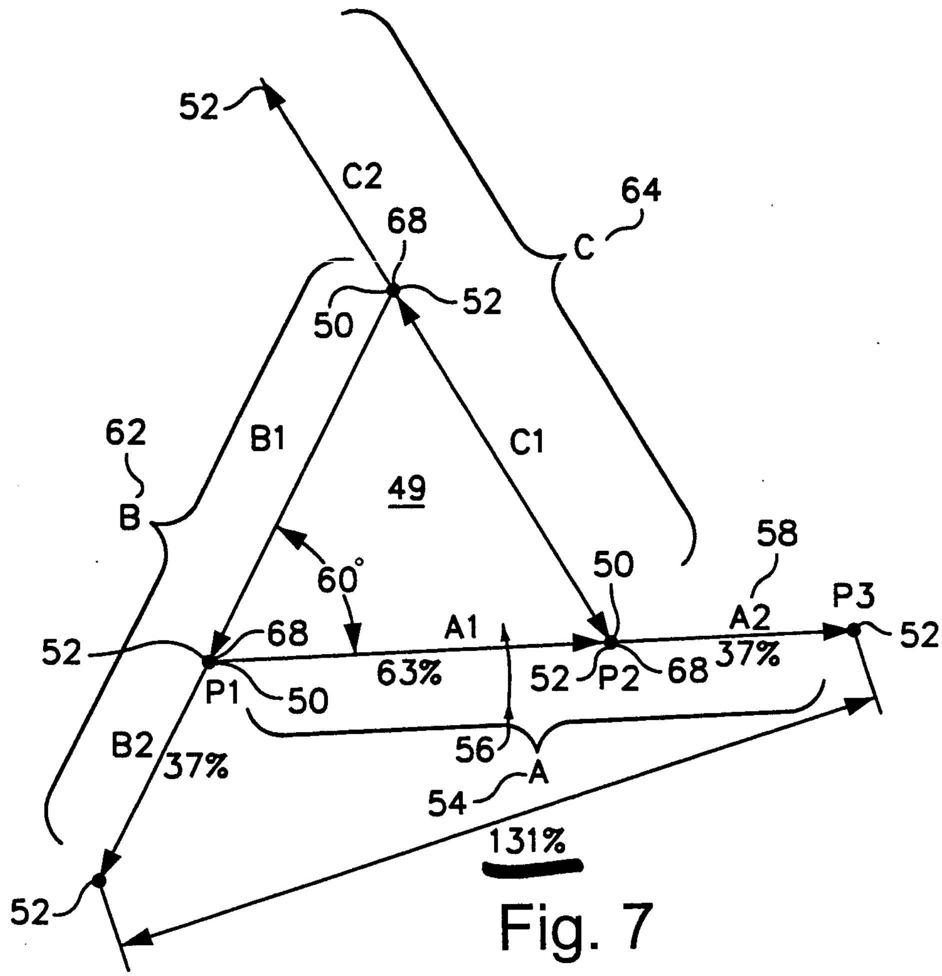


Fig. 7

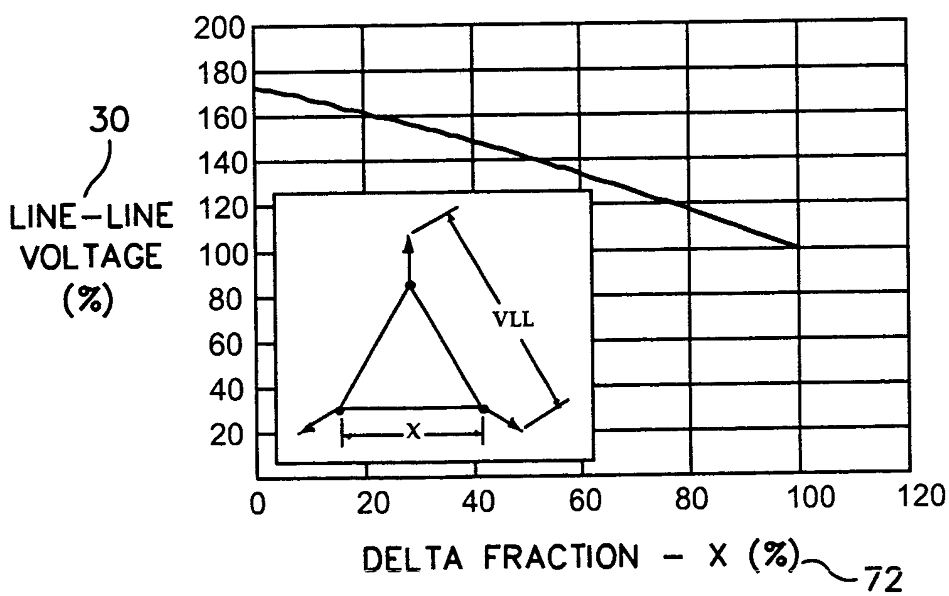


Fig. 8

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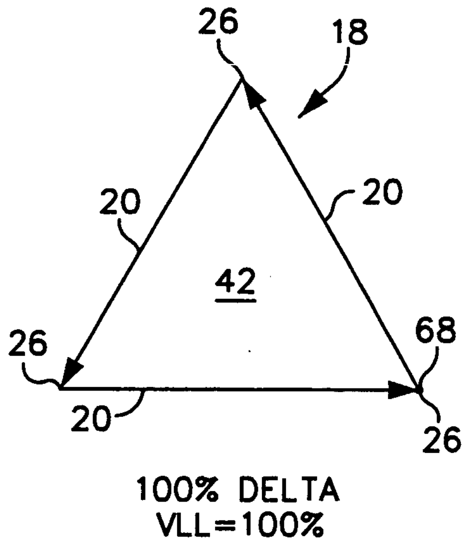


Fig. 9

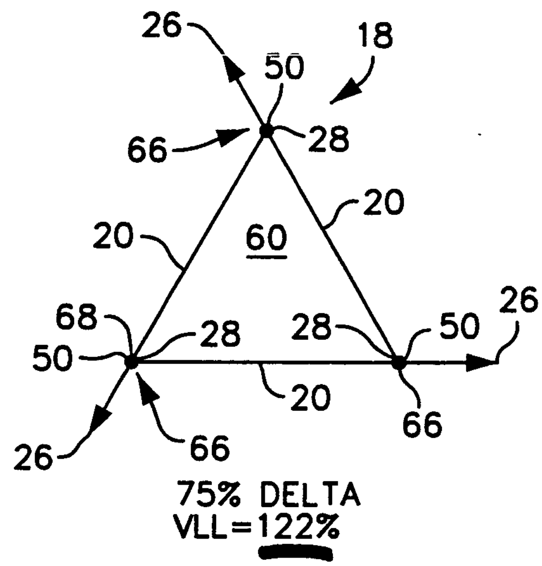


Fig. 10

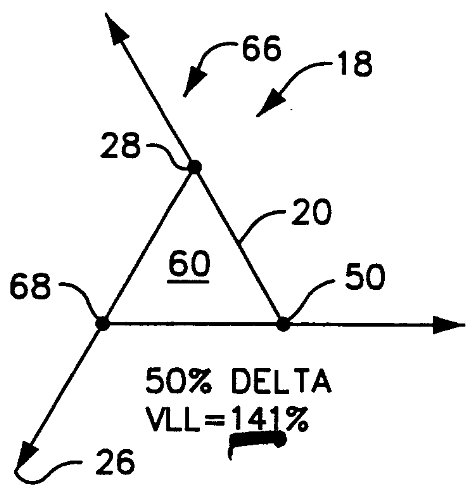


Fig. 11

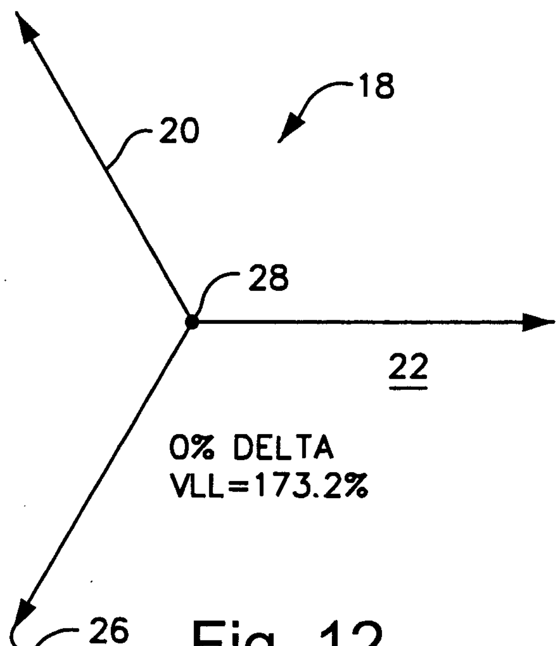


Fig. 12